TREATMENT OF HYPERTROPHY OF THE INFERIOR TURBINATE: LONG-TERM RESULTS IN 382 PATIENTS RANDOMLY ASSIGNED TO THERAPY

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A number of surgical techniques are commonly performed to control the symptoms of inferior turbinate hypertrophy unresponsive to medical treatment. We report long-term results in 382 patients randomly assigned to receive electrocautery (62), cryotherapy (58), laser cautery (54), submucosal resection without lateral displacement (69), submucosal resection with lateral displacement (94), and turbinectomy (45). Outcomes of objective test results from rhinomanometry, acoustic rhinometry, mucociliary transport time, and secretory immunoglobulin A levels were compared to the symptom scores before and yearly after surgical treatment. These data indicate that submucosal resection with lateral displacement of the inferior turbinate results in the greatest increases in airflow and nasal respiratory function with the lowest risk of long-term complications.

KEY WORDS — inferior turbinate hypertrophy, inferior turbinate surgery.

INTRODUCTION

Although it is not a life-threatening condition, nasal obstruction can interfere with the quality of life. If septal defects are excluded, the main structures contributing to this problem are the nasal turbinates, especially the inferior turbinates. Perennial allergic rhinitis and nonallergic rhinitis are the most common noninfectious causes of mucosal swelling of the inferior turbinates and reduced nasal airflow. Untreated, these conditions may result in chronic nasal obstruction secondary to dilation of the venous sinuses or fibrosis.

Surgical procedures on the enlarged inferior, and sometimes middle, turbinates are the only effective therapy in these cases. However, selection of the procedure of choice among the several available techniques appears to be based more on personal attitudes than on a critical assessment of the treatment outcomes. In fact, since the first experiences in turbinal surgery performed by Hartmann in the 1890s,[1] the large number of surgical procedures with reported benefits suggests a lack of consensus about the most effective technique.

The principal procedures in current use are cauterization, cryosurgery, submucosal resection with or without outfracture, and resection of the turbinate. Each procedure has recognized advantages and disadvantages. We review our experience with each of these procedures in patients with inferior turbinate hypertrophy unresponsive to medical therapy. Outcomes were based on objective studies and a structured questionnaire over 4 years of follow-up.

PATIENTS AND DIAGNOSIS

Four hundred fifty-seven patients, 256 males and 201 females (age range 8 to 70 years, median age 38 years) with intractable nasal obstruction due to chronic allergic or vasomotor rhinitis and operated on at the otolaryngology clinic of the University of Siena, were included in the present study.

Patients with infectious rhinitis or marked septal deviation were excluded from the trial. Other exclusion criteria were previous nasal surgery, nasal polyps or sinusitis contributing to the nasal obstruction, significant improvement after medical treatment with steroid nasal sprays, and other major nasal diseases.

Each patient underwent the following diagnostic protocol.

1. Clinical history.
2. Clinical examination.
3. Skin tests by prick testing for grass pollen, *Parietaria*, and *Dermatophagoides* to identify hypersensitive subjects.
4. Dosage of specific immunoglobulin E (IgE) by radioallergosorbent test (RAST).

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TABLE 1. QUESTIONNAIRE ON SYMPTOMS COLLECTED EVERY YEAR AT CONTROL

Please express your evaluation on						
Nasal obstruction during the day:	1	2	3	4	5	6
Nasal obstruction during the night:	1	2	3	4	5	6
Please express your evaluation on						
Nasal discharge during the day:	1	2	3	4	5	6
Nasal discharge during the night:	1	2	3	4	5	6
Please express your evaluation on sensation of ear fullness:	1	2	3	4	5	6

Symptoms must be graded according to a 1-6 scale where 1 is the absence of symptoms and 6 is maximum severity of symptoms.

5. Nasal decongestion test (NDT) carried out by baseline recording of nasal resistance by anterior active rhinomanometry (Rynosystem Amplifon) according to a committee report on the standardization of rhinomanometry[2]; insufflation of a local vasoconstrictor (tramazoline hydrochloride) into each nasal cavity; and repeat recording of nasal resistance after 10 minutes. If the nasal resistance normalized or improved, the test was considered positive. If the nasal resistance remained unchanged, the finding was judged to be abnormal.[2] All the patients in the present study had abnormal NDT results.

6. Acoustic rhinometry performed by a Rhinoklack RK 1000 to assess the morphologic and geometric situation of the nasal cavity.

7. Measurement of nasal mucociliary transport time (MCTT) using charcoal powder placed on the inferior turbinate. The normal time to appearance of the charcoal indicator in the oropharynx is 13 ± 2 minutes.[3] When the MCTT exceeds 30 minutes, we consider the transport to be blocked and interrupt the observation.

8. Measurement of nasal secretory immunoglobulin A (IgA). Specimens were obtained by inserting 2 small cotton swabs into each nasal fossa, between the septum and the middle and inferior turbinates, under anterior rhinoscopy. Twenty minutes later, the swabs were removed by a bayonet forceps and inserted into an insulin syringe to squeeze out the secretion into a test tube. Specimens were analyzed immediately or frozen for later analysis.[4]

9. A questionnaire on symptoms, administered every year during the controls. The patients graded the following symptoms: nasal obstruction during the day and night, nasal discharge during the day and night, and sensation of ear fullness according to a scale of 1 to 6 (Table 1).

SURGICAL TECHNIQUES

The following procedures were performed: 1) electrocautery in 62 patients (group 1); 2) cryotherapy in 58 patients (group 2); 3) laser cautery in 54 patients (group 3); 4) submucosal resection without lateral displacement in 69 patients (group 4); 5) submucosal resection with lateral displacement in 94 patients (group 5); and 6) turbinectomy in 45 patients (group 6). Patients were assigned randomly to 1 of the 6 groups. Each of the 10 surgeons involved performed a balanced percentage of each type of operation, using the same technique. Residents were not involved. All the surgical procedures were carried out under local anesthesia.

Electrocautery. Inferior turbinate cauterization was done by applying a high-frequency coagulation current via a round point electrode at constant power. The electrode was introduced as far as the posterior end of the nasal cavity. The coagulation was carried out on the medial surface from behind forward, 2 to 4 times, 10 seconds each time. At the end of the intervention, Merocel packs were placed for 3 days to avoid the formation of synechiae between the turbinate and septum.[5]

Cryotherapy. The nasal probe of a standard cryogenic unit using nitrogen protoxide was applied along the free edge and then on the medial face at 2 overlapping levels for 2 minutes, at a temperature of –80°C. Merocel nasal packing was left in each side for 3 days.[6-8]

Laser Cautery. Coagulation of the inferior turbinates was done with a carbon dioxide laser (Coherent MP20 laser) delivering 300 impulses per second at 10 to 15 W. The laser spot was the same size as the point of the electrocautery needle. A 2.5-millisecond interval was left between consecutive applications to avoid excessive carbonization. Packing was not necessary.[9,10]

Submucosal Resection Without Lateral Displacement. Through a 3- to 4-mm incision on the head of the inferior turbinate, the submucosal tissue was dissected from the medial surface and inferior edge of the bone by an elevator. Excess cavernous tissue was removed with Hartmann forceps with resection of the posterior end of the turbinate. Merocel packing was used[1,11,12] (Fig 1).

Submucosal Resection With Lateral Displacement. This procedure was identical to the above plus outfracture and lateral displacement of the turbinal bone by a Goldman displacer[13,14] (Fig 2).

Turbinectomy. After medial and upward fracture, the inferior turbinate was resected by angled scissors along the insertion close to the lateral nasal wall. Merocel nasal packing was used for 3 days to control bleeding.[15-17]

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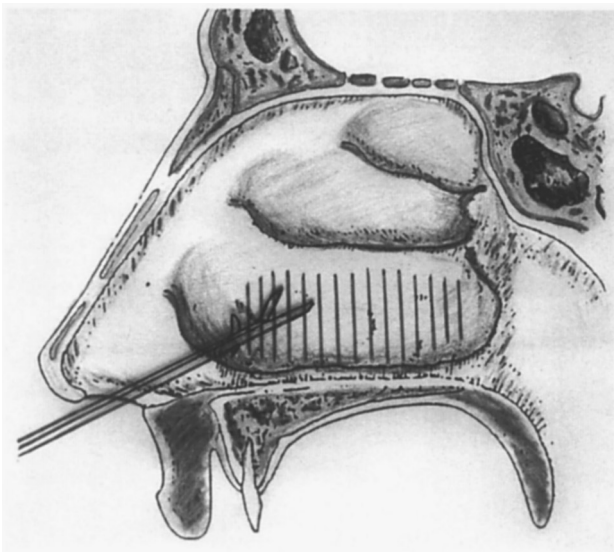

Fig 1. Submucosal resection.

In all cases, nasal packing was used without a topical antibiotic. All patients received a third-generation cephalosporin for 6 days.

RESULTS

Of the 457 patients entered into the trial, 382 were available for follow-up. The follow-up was 4 years in 100 patients, 3 years in 91 patients, 2 years in 107 patients, and 1 year in 84 patients.

Forty percent (182) of the patients admitted to the study proved to be allergic. Nasal hyperactivity was triggered by *Dermatophagoides* in 30% (54) of cases, by grass pollen in 10% (18), and by both allergens in 60% (110).

Results were assessed by measures of 1) patency as indicated by nasal resistance and acoustic rhinometry, 2) MCTT, 3) secretory IgA, 4) symptom score, and 5) complications.

Patency. Nasal resistance values are presented in Table 2. Although the average resistance values were

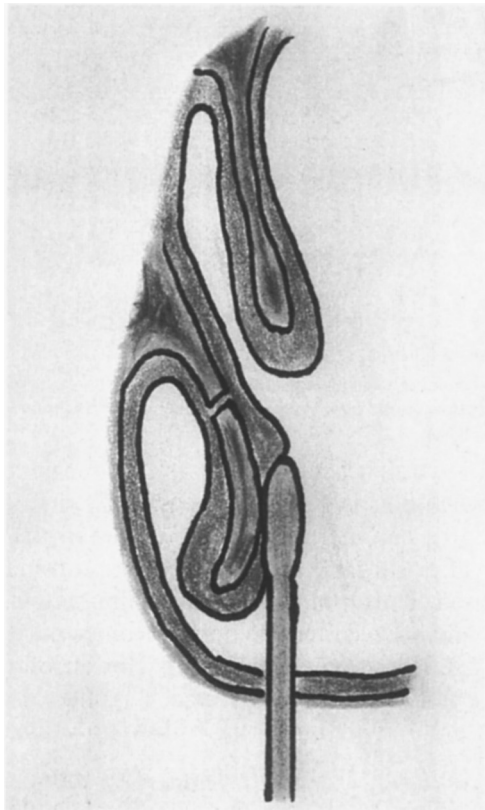

Fig 2. Lateral displacement after submucosal resection.

improved in all groups from the preoperative level, the duration of improvement varied by treatment group. The least improvement occurred in the electrocautery group, and these values worsened yearly to become abnormal by the third postoperative year. Normal nasal patency was restored in the other groups and remained normal for the remainder of the study period. The greatest improvement was seen in the turbinectomy group.

Table 3 shows the morphologic status of the nasal cavities as documented by acoustic rhinometric measurements. All groups had increased volume during the first year, with worsening in the electrocautery, laser, and cryotherapy groups in the later years. It is

TABLE 2. NASAL RESISTANCE VALUES MEASURED BY RHINOMANOMETRY

Time of Enrollment	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
1st y (n = 100)	0.80 ± 0.13 (n = 15)	0.6 ± 0.11 (n = 16)	0.5 ± 0.09 (n = 14)	0.45 ± 0.09 (n = 20)	0.45 ± 0.09 (n = 24)	0.3 ± 0.09 (n = 11)
2nd y (n = 91)	0.85 ± 0.14 (n = 29)	0.6 ± 0.12 (n = 30)	0.55 ± 0.10 (n = 27)	0.45 ± 0.09 (n = 39)	0.45 ± 0.09 (n = 45)	0.3 ± 0.09 (n = 21)
3rd y (n = 107)	1.2 ± 0.33 (n = 47)	0.9 ± 0.26 (n = 45)	0.5 ± 0.10 (n = 43)	0.5 ± 0.11 (n = 53)	0.45 ± 0.10 (n = 75)	0.45 ± 0.10 (n = 35)
4th y (n = 84)	1.5 ± 0.41 (n = 62)	1.0 ± 0.29 (n = 58)	0.6 ± 0.14 (n = 54)	0.5 ± 0.12 (n = 69)	0.45 ± 0.12 (n = 94)	0.45 ± 0.09 (n = 45)

Data are in pascals per cubic centimeter per second (mean ± SD). Before surgery, mean value of resistance was 1.2 Pa/cm^3 per second.

n — number of subjects (total = 382); group 1 — electrocautery; group 2 — cryotherapy; group 3 — laser cautery; group 4 — submucosal resection; group 5 — submucosal resection with displacement; group 6 — turbinectomy.

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TABLE 3. NASAL VOLUMES MEASURED BY ACOUSTIC RHINOMETRY

Time of Enrollment	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
1st y (n = 100)	8.5 ± 1.35 (n = 15)	9.3 ± 1.31 (n = 16)	10.4 ± 2.52 (n = 14)	12.4 ± 2.96 (n = 20)	11.5 ± 2.34 (n = 24)	12.5 ± 1.95 (n = 11)
2nd y (n = 91)	7.3 ± 1.28 (n = 29)	7.6 ± 1.14 (n = 30)	9.5 ± 2.37 (n = 27)	10.2 ± 2.05 (n = 39)	10.2 ± 2.15 (n = 45)	11.8 ± 2.15 (n = 21)
3rd y (n = 107)	5.5 ± 1.12 (n = 47)	5.7 ± 1.03 (n = 45)	8.1 ± 2.12 (n = 43)	11.3 ± 2.14 (n = 53)	11.1 ± 2.47 (n = 75)	11.7 ± 2.03 (n = 35)
4th y (n = 84)	4.5 ± 1.13 (n = 62)	4.9 ± 0.98 (n = 58)	7.4 ± 1.93 (n = 54)	11.4 ± 2.41 (n = 69)	11.7 ± 2.39 (n = 94)	11.8 ± 2.01 (n = 45)

Data are in cubic centimeters (mean ± SD). Mean value before surgery was 4.8 cm^3.

n — number of subjects (total = 382); group 1 — electrocautery; group 2 — cryotherapy; group 3 — laser cautery; group 4 — submucosal resection; group 5 — submucosal resection with displacement; group 6 — turbinectomy.

well known that acoustic rhinometry measures the volume of the nasal cavity. So, acoustic rhinometry will register an increase of the volume of the nasal cavity after surgery, as the size of the turbinates is decreased. Unfortunately, so far, rhinometry is not well standardized, and the normal values are not established. However, we believe that the absolute values are not very important, and it is interesting to evaluate the trend during the follow-up years.

Mucociliary Transport Time. The mucociliary clearance test results are shown in Table 4. The average MCTTs remained abnormal, except in the 2 groups undergoing submucosal resection.

Secretory IgA. A similar trend occurred with secretory IgA production (Table 5). Normal average values (80 to 100 mg/100 mL) were reached only in patients receiving submucosal resection, and the combination with lateral displacement ensured the best results.

Symptom Severity Score. The trend of the symptom score in each group is recorded in Table 6 and shows the best results to be in patients treated by submucosal resection. Symptoms worsened in groups 1 and 2 in parallel to the decrease in nasal patency.

Complications. Surgical complications are presented in Fig 3 and Table 7. The patients in groups 1 to 3 had the greatest problem with chronic crusting, due to the nasal physiology impairment, and synechia formation. Bleeding was noted only in groups 4 to 6, reaching clinically troublesome levels only in group 6, with true hemorrhages in 25 patients in the total turbinectomy group.

Composite Analysis. To compare the effectiveness of the procedures, analysis of variance was performed year by year. With rhinomanometric results, a statistically significant difference ($p > .05$) was found in favor of submucosal resection with lateral displacement (group 5) in comparison with groups 1 to 3.

A statistically significant difference between group 5 and groups 1, 2, 3, and 6 was noted when the dependent variable was 1) acoustic rhinometry results ($p > .01$), 2) MCTT, or 3) symptom score ($p > .01$).

DISCUSSION

Cauterization, cryotherapy, and laser cautery are associated with only short-term benefit to airway patency and with troublesome complications of crusting. The decreased bleeding, lack of postoperative pain, and faster healing after laser cauterization do

TABLE 4. MUCOCILIARY TRANSPORT TIME

Time of Enrollment	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
1st y (n = 100)	26 ± 1.64 (n = 15)	25 ± 1.92 (n = 16)	27 ± 1.78 (n = 14)	20 ± 2.45 (n = 20)	21 ± 2.15 (n = 24)	29 ± 0.92 (n = 11)
2nd y (n = 91)	25 ± 1.57 (n = 29)	26 ± 2.15 (n = 30)	27 ± 1.67 (n = 27)	20 ± 2.36 (n = 39)	18 ± 1.83 (n = 45)	28 ± 0.73 (n = 21)
3rd y (n = 107)	26 ± 1.49 (n = 47)	26 ± 2.05 (n = 45)	26 ± 1.83 (n = 43)	18 ± 2.15 (n = 53)	15 ± 1.75 (n = 75)	29 ± 0.85 (n = 35)
4th y (n = 84)	25 ± 1.93 (n = 62)	25 ± 1.93 (n = 58)	27 ± 1.90 (n = 54)	20 ± 2.41 (n = 69)	15 ± 1.68 (n = 94)	29 ± 0.95 (n = 45)

Data are in minutes (mean ± SD). Normal value (for charcoal powder) is 13 ± 2 minutes. When time exceeds 30 minutes, we consider blockage to be present and interrupt observation.

n — number of subjects (total = 382); group 1 — electrocautery; group 2 — cryotherapy; group 3 — laser cautery; group 4 — submucosal resection; group 5 — submucosal resection with displacement; group 6 — turbinectomy.

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TABLE 5. IMMUNOGLOBULIN A CONCENTRATION IN NASAL SECRETIONS

Time of Enrollment	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
1st y (n = 100)	10 ± 2.5 (n = 15)	08 ± 2.2 (n = 16)	10 ± 2.4 (n = 14)	40 ± 8.3 (n = 20)	38 ± 8.1 (n = 24)	20 ± 5.3 (n = 11)
2nd y (n = 91)	10 ± 2.6 (n = 29)	12 ± 2.8 (n = 30)	11 ± 2.2 (n = 27)	35 ± 7.8 (n = 39)	40 ± 8.6 (n = 45)	15 ± 4.6 (n = 21)
3rd y (n = 107)	12 ± 2.9 (n = 47)	10 ± 2.7 (n = 45)	15 ± 2.9 (n = 43)	40 ± 8.4 (n = 53)	52 ± 9.5 (n = 75)	18 ± 4.8 (n = 35)
4th y (n = 84)	18 ± 3.1 (n = 62)	15 ± 2.8 (n = 58)	10 ± 2.5 (n = 54)	53 ± 9.2 (n = 69)	70 ± 12.8 (n = 94)	20 ± 5.5 (n = 45)

Data are in milligrams per 100 milliliters (mean ± SD). Normal value is 80 to 100 mg/100 mL.

n — number of subjects (total = 382); group 1 — electrocautery; group 2 — cryotherapy; group 3 — laser cautery; group 4 — submucosal resection; group 5 — submucosal resection with displacement; group 6 — turbinectomy.

not justify the disadvantages such as the expensive instrumentation and risk of synechia formation. Thus, the laser offers no advantage over simpler surgical instruments.

Submucosal resection of the vascular tissue within the turbinate had the least complications (bleeding, crusting) and the greatest improvement in mucociliary clearance and local secretory IgA production. The longer hospital stay is counterbalanced by the absence of bleeding and the minimal crusting. This conservative technique gives good results in the majority of cases and is well tolerated. In Italy we also have to consider hospital stay, because, unlike in other countries, we hospitalize patients submitted to turbinate surgery.

The 94 patients who underwent submucosal resection (groups 4 and 5) obtained the best results. Adding lateral displacement (group 5) to the procedure incurred no additional risk and resulted in marginally better results. In fact, the long-lasting increase of nasal patency that returned to normal values was accompanied by the normalization of MCTT and local secretory IgA production. Therefore, we recommend the additional step of turbinate outfracture when performing submucosal resection of the turbinate tissue.

Outfracture of the inferior turbinate (without submucosal resection) does not significantly affect the nasal airway, even when combined with amputating the posterior end of the turbinate. In fact, anterior rhinomanometry showed that any eventual improvement is not predictable in any specific patient and that it is short-lasting. Therefore, outfracture, of which the advantages are the absence of risk of postoperative nasal adhesions and the minimal possibility of developing atrophic rhinitis, either produces a modest increase in nasal patency[14] or is unable to correct the nasal obstruction.

In contrast, lateral displacement of the inferior turbinate improves the results obtained with submucosal resection, because hypertrophy reduction and lateralization are both obtained. Although a statistically significant difference was not observed in the present study comparing submucosal resection with and without lateral displacement, the additional surgical step appears to improve outcome without any additional risk.

Turbinectomy had the greatest effect on nasal obstruction, but its adverse effect on the other nasal functions, as shown by poor results of MCTT and secretory IgA testing and by secondary hemorrhage, limits the usefulness of this technique. Increased air-

TABLE 6. TOTAL SYMPTOM SCORE

Time of Enrollment	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
1st y (n = 100)	20 ± 2.25 (n = 15)	21 ± 3.11 (n = 16)	21 ± 2.45 (n = 14)	10 ± 1.59 (n = 20)	10 ± 1.43 (n = 24)	21 ± 2.43 (n = 11)
2nd y (n = 91)	22 ± 2.78 (n = 29)	22 ± 3.34 (n = 30)	24 ± 3.10 (n = 27)	12 ± 1.79 (n = 39)	10 ± 1.67 (n = 45)	20 ± 2.35 (n = 21)
3rd y (n = 107)	26 ± 3.76 (n = 47)	27 ± 3.85 (n = 45)	18 ± 2.11 (n = 43)	12 ± 1.81 (n = 53)	10 ± 1.85 (n = 75)	22 ± 2.72 (n = 35)
4th y (n = 84)	26 ± 3.82 (n = 62)	25 ± 3.78 (n = 58)	20 ± 2.23 (n = 54)	12 ± 1.89 (n = 69)	10 ± 1.72 (n = 94)	20 ± 2.11 (n = 45)

Data are in points (mean ± SD). Questionnaire on symptoms was administered every year at control visit. Patients graded following symptoms: nasal obstruction and nasal discharge during day and night, and sensation of ear fullness, according to 1-6 scale.

n — number of subjects (total = 382); group 1 — electrocautery; group 2 — cryotherapy; group 3 — laser cautery; group 4 — submucosal resection; group 5 — submucosal resection with displacement; group 6 — turbinectomy.

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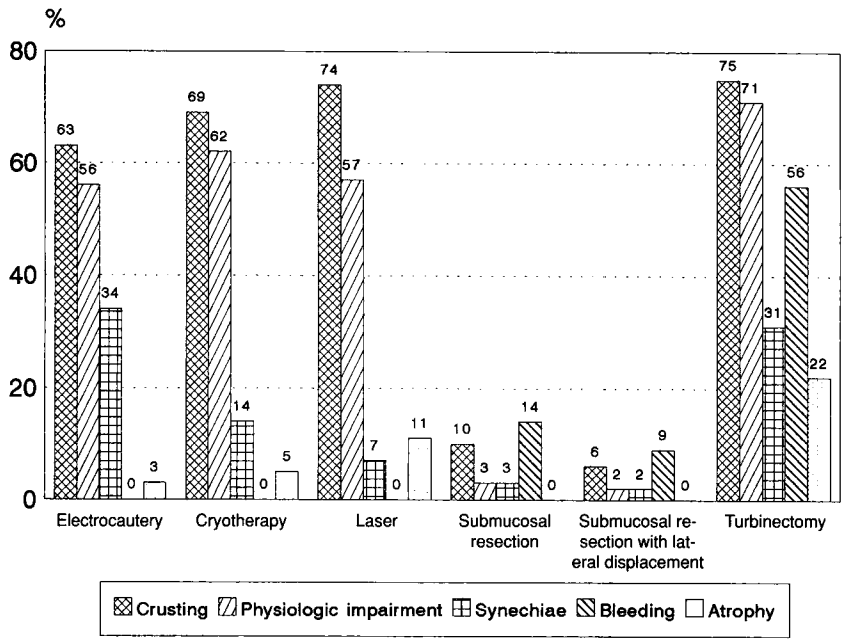

Fig 3. Percentage of patients having complications. Bleeding was absent in electrocautery, cryotherapy, and laser groups. Atrophy was absent in both submucosal resection groups.

flow and the macroturbulence produced by the modified nasal anatomy are responsible for excessive drying of nasal secretions and crusting.

Epiphora due to the damage of opening the nasolacrimal duct is uncommon, except for cases of unusual duct opening up to 10 mm below the attachment of the inferior turbinate. Dawes[18] and Cook et al[19] noted a significant risk of primary hemorrhage following turbinectomy (8.9% to 10% of patients). Salam and Wengraf[20] noted that increase of nasal airflow corresponded to a decrease in the humidifying activity of the nasal mucosa.

Although atrophic rhinitis is a rare complication of total inferior turbinectomy, more frequent in patients with poor hygiene and nutrition, many authors recommend removal of only the portion of the turbinate necessary to treat the airway obstruction, avoiding radical resection of the inferior turbinate.

CONCLUSIONS

Each procedure for surgical management of chronic nasal obstruction has been noted to have distinct advantages and drawbacks, leading to the general teaching that no one operation is "right" for every case and that surgery should be individualized. However, the results of this study permit us to draw specific conclusions. It is clear that the more conservative techniques must be preferred, because they provide effective control of the vasomotor disturbances without interfering with the anatomy and physiology of the turbinates.

These results indicate that the dramatic improvement in nasal airflow following complete resection of the inferior turbinates is accompanied by a clinically significant loss of humidification and warming of the inspired air, decreased efficiency of mucociliary transport, and reduced secretory IgA defense activities. Thus, even if turbinectomy has excellent results in relieving nasal obstruction, it is associated with more pain and crusting, long-term dryness, and an increased infection rate.

A follow-up of 4 years is long enough to evidence the normalization of physiological parameters when submucosal resection with or without lateral displacement is performed. During the same period of time, no significant improvements are observed for

TABLE 7. COMPLICATIONS

Complications	*Group 1 (n = 62)*	*Group 2 (n = 58)*	*Group 3 (n = 54)*	*Group 4 (n = 69)*	*Group 5 (n = 94)*	*Group 6 (n = 45)*
Crusting	39	40	40	7	6	34
Physiologic impairment	35	36	31	2	2	32
Synechiae	21	8	4	2	2	14
Bleeding	0	0	0	10	8	25
Atrophy	2	3	6	0	0	10

Data are numbers of subjects.

n — number of subjects; group 1 — electrocautery; group 2 — cryotherapy; group 3 — laser cautery; group 4 — submucosal resection; group 5 — submucosal resection with displacement; group 6 — turbinectomy.

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nonconservative surgical procedures such as turbinectomy.

In our opinion, a longer follow-up could only confirm our results. In fact, the increased airflow and macroturbulence throughout the nasal cavities following turbinectomy represent the pathophysiological basis of nasal drying and crusting.

As a consequence, the nasal physiological impairment must be considered permanent, having as its substratum irreversible anatomic alterations.[21,22]

Without doubt, elevation of a mucoperiosteal flap is technically more difficult than full thickness excision. This may be one of the reasons many surgeons prefer total or partial turbinectomy to submucosal resection, in spite of the better nasal physiology with the latter procedure.

We recommend submucosal resection combined with lateral displacement as a first-choice operation in cases of nasal obstruction due to hypertrophy of the inferior turbinates.

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